Chapter 6
Ultrasound in Combat Trauma

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Deployment Experience:

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BLUF Box (Bottom Line Up Front)

1. Never delay transport to OR for any radiologic study in these patients with clear indications for immediate operative intervention, but Ultrasound (US) can give quick and useful data in patients who are foregoing CT scan enroute to the OR.
2. US is much more sensitive than supine CXR in blunt/penetrating trauma in experienced hands and US should not be delayed for plain radiography in most situations.
3. US should be performed after the ABCs have been addressed: think "ABC-U."
4. Repeat EFAST is good; do it early and, if normal, repeat it since hemoperitoneum and hemothorax may take time to accumulate.
5. US is operator dependent, so always consider the skill and experience of the US operator and his/her confidence level prior to interpreting US findings.
6. Injuries on today's battlefield often include varying combinations of burn, penetrating and blunt trauma. In severely burned patients, the EFAST can quickly identify other life-threatening injuries as you aggressively manage the patient's thermal wounds.
7. US can give vital information that providers can use in making immediate triage decisions in the trauma patient(s) who is in extremis or full arrest.
8. Use down time during your deployments to get comfortable (or proficient!) with US.

"*Failure to immediately recognize and treat simple life-threatening injuries is the tragedy of trauma, not the inability to handle the catastrophic or complicated injury*."

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Why Ultrasound?

Ultrasound is an important part of the initial trauma workup, no matter the setting. Most surgeons will be practicing at a Combat Support Hospital (CSH) in theatre; however, as a part of a FST you might not have a CT scanner available. In austere scenarios, US can be invaluable in directing resuscitative and operative management, but US should also be a part of the CSH or trauma center evaluation. Admittedly, many civilian trauma centers have such quick access to CT scanning that US is largely bypassed with the advent of the “pan-scan.” With multiple patient and mass casualty scenarios quickly overwhelming CT capabilities; however, US can be crucial in getting the trauma team useful information quickly.

Ultrasonography as a tool in wartime trauma management really just started to gain widespread use during the First Gulf War, and it is finding its way closer to the frontline as OIF/OEF continues. While most recently graduated surgeons and emergency physicians have seemed to embrace US, it can be challenging for providers who did not receive residency training in US. Most are familiar with US, but lack the training and hands-on experience to really become adept at this skill. That’s the rub; not only does the trauma doctor need to know how to interpret and act on US images, he/she must also learn the skill of obtaining usable images *in an acceptable amount of time*. You do not need to be an expert to use US, but the knowledge and skills will degrade if not practiced continually.

This brief chapter is not designed to take the place of proper US training or an US course, but rather to give an overview and some references/reminders for US applications. I personally was comfortable and competent to perform US, yet did not feel that I was truly proficient until I had performed dozens of extended trauma ultrasound exams during my first month of deployment. There is a big difference between thinking a patient probably has a pneumothorax on US, and actually knowing it exists (*and* placing a chest tube based on your US findings without obtaining other radiologic studies). If you are a deploying surgeon or physician who will be managing any type of combat casualties, then you *must* become familiar with the basics of ultrasound and the standard trauma exams (focused assessment with sonography for trauma or FAST) *before* you deploy. With very little additional time and effort, you can add the skill set of basic thoracic imaging to perform the extended FAST exam (EFAST).

The great news is that most of us will be deployed with easy access to an ultrasound machine and deployment is the perfect time to refine/maintain our US competency. Tap into the US expertise of skilled ultrasonographers in your unit, be it the radiologist, emergency physicians or trauma surgeons. Apply the skills you know and practice repeatedly on your medics or EMT patients until you feel very comfortable with the probe positioning and the images you obtain. If we cannot do this quickly in a trauma resuscitation, team members can get annoyed and the slow ultrasonographer usually gets pushed out of the way. We must be able to obtain the information in a timely manner, or this modality isn’t very helpful. If time allows, as you refine your skills, go back to the stable trauma patient who has already had a positive CT finding and perform an US. Alternatively, bring the machine to the ICU and perform exams on patients with known intraperitoneal fluid (usually postop) or cardiac effusions. Recognizing positive findings and learning how intraperitoneal blood, pericardial blood/fluid or intrathoracic blood/air looks on US is a critical part of attaining proficiency. Most of us won't attain proficiency until we have performed and interpreted numerous positive EFAST scans, in addition to our "training" scans on normal patients.

Have your unit purchase at least one US machine *prior* to deploying; it will be invaluable no matter what the combat setting. If deploying with a CSH, I highly recommend getting your Command and supply personnel to help purchase multiple units. While deployed with a CSH, we had two older US units in the Emergency Room that were in constant demand from intensivists, radiologists and cardiologists. There were times when we needed them for EFAST in critical patients but they were being used in the ICU, so think about this ahead of time since it can be very hard to get additional or upgraded US units in theater. Also have your supply folks consider the wear and tear and coordinate with the manufacturers for replacement parts and repair ahead of time.

Advantages of US

1. Essentially replaces DPL (quicker, non-invasive, not overly sensitive) in most scenarios.
2. Tells you if there is significant blood in the abdomen, chest or pericardium, allowing you to more quickly perform necessary interventions (including exploratory laparotomy or emergent thoracotomy).
3. Identifies pneumothorax quickly and easily. This is very useful in managing patients in the field, or at a level I or II facility where US is the only available radiologic modality.
4. Show us what is happening at a given point and time. Serial EFAST scans, after rolling the patient or after placing them in Trendelenburg position, increases the sensitivity in the stable patient.
5. Done at quickly at bedside; no need to send unstable patients to the "black hole" of radiology. Gives additional, immediate data in patients being taken straight to the OR.
6. No contrast or radiation exposure.

Disadvantages of US (for the Average Ultrasonographer)

1. May miss small hemoperitoneum (about >100–200 ml needed to be seen with US)
2. Does not normally identify the site of intraabdominal bleeding

3. Does not show hollow viscus injuries well
4. Does not reliably show retroperitoneal bleeding
5. Does not tell us if free fluid present is blood, ascites, urine or (in chest) pleural effusion
6. Relatively insensitive in pediatric patients (although helpful if positive)
7. Unable to perform US in certain patients due to body habitus, air, etc…

How to Perform an EFAST

The EFAST (Extended Focused Assessment with Sonography in Trauma) is the basic exam used to evaluate thoracoabdominal injury. While there are different variations on the order of performing the views, I will describe the way I do it. There are four basic views that are usually obtained in the traditional FAST exam: right upper quadrant (RUQ), left upper quadrant (LUQ), pericardium, and pelvic. The "E" or extended portion of the EFAST came about after thorax scanning for pneumothorax was added later. Evaluation for hemothorax is more commonly being performed as part of the EFAST. Search for blood above the diaphragms as you do the RUQ/LUQ abdominal views. Below is an explanation of basic techniques for obtaining views; however, realize that the EFAST is a dynamic process that takes into account multiple images of each view as we look for air and blood. Slide the probe around and look at each view from different angles to increase your sensitivity. Placing the patient in Trendelenburg may increase the sensitivity of your RUQ view if you are unsure if there is fluid on the pelvic view. Also, recall that a negative EFAST might still be missing accumulating blood in the intraperitoneal space and that results should not be used in isolation when managing a trauma patient. EFAST should be repeated in certain clinical settings if initially negative. We should view US as a dynamic process and interpret results in light of the patient's clinical picture and stability.

Basic Terms and Knobology

Not to get too technical, but we need to use certain terms to communicate in US lingo. Basically, an US probe (transducer) pushes out acoustic waves and detects reflected waves (from dense matter) that bounce back to the US probe. US waves that pass through homogenous material do not reflect back to the probe and are termed *anechoic* (completely black, implies homogenous fluid such as urine, unclotted blood, or water). Most other organs and structures in the body are represented in shades of gray (or degrees of echogenicity), as sounds waves pass through them with varying degrees of reflection back toward the probe. The more *hypoechoic* the structure, the more fluid filled and homogenous they are (and the darker they appear on US). *Hyperechoic tissue* is generally more dense and reflective (higher impedance, like bone), showing up white or lighter-gray on US. Isoechoic means that adjacent tissue has similar appearance (or echogenicity), due to similar degrees of impedence. Examples of varying degrees of echogenicity, from darker to lighter (anechoic to hyperechoic) are: water-fat-liver-tendon-bone). Remember, air is the sonographer's enemy; sound waves transmit poorly through air (due to scatter) in comparison to fluids and solid organs and thus limits our exams when present. Large amounts of air in the intestine can render an abdominal US meaningless if we cannot navigate around it. Conversely, echodense structures such as the liver provide excellent sound wave transmission and can serve as a window to examine deeper structures.

The knobs on the US machine vary greatly depending on the make/model of the machine, so get to know your machine so you can tell which knob does what. The most important knob (other than the power switch) is the gain. *Gain* is basically how much amplification comes from the transducer. The more you turn it up, the more white all structures will appear on the screen. Inappropriate gain can make interpretation difficult, so adjust the gain until images look "about right;" (yes, this is subjective and the more scans you do, the better idea you will have of what your images should look like). The other important knob to find is the depth. Adjust the *depth* knob to ensure the area you are imaging fits in the middle of the screen and isn't too deep (image of interest appears small at the top of the screen – hard to see details) or too shallow (area of interest extends beyond bottom of screen). There are usually markers on the side of the image that give a scale in centimeters for depth. A normal starting depth for the abdominal portion of the EFAST is in the 12–19 cm range. The other buttons can be useful in some situations, but not mandatory for doing a basic EFAST exam.

Probes come in different sizes, shapes and design. The higher the frequency probe, the less penetration and more detail and resolution you get. Most EFAST views should be performed using low frequency probes (2–5 MHz), while the high frequency probes (5–10 MHz) are great for pneumothorax studies and superficial applications (soft tissue, vascular access). I prefer a high frequency probe for pneumothorax scans, but the abdominal/low frequency probe can also be utilized. I recommend using the smaller footprint phased array transducer (looks like a square box) to allow shooting through ribs without interference for the EFAST views, although some prefer the larger, curve shaped low frequency abdominal probe because of better image quality. All probes have a *transducer indicator* for orientation; the image on the US screen has a colored dot that correlates with the end of the transducer that has the marker. The general convention is to orient the indicator toward the patients' right side (for transverse/axial imaging), or towards the patients' head (for sagittal and coronal imaging).

It helps to be familiar with the characteristics of each probe and choose the one with which you feel most comfortable when performing an application. As an aside, make sure the trauma team members know how to clean the probes and to keep them off the ground and secured when moving the unit. A damaged probe can cost tens of thousands of dollars if the cord is run over or the probe dropped.

Abdomen

RUQ (Perihepatic or Hepatorenal) View

Free intraperitoneal blood is most often identified in Morison's pouch, between the liver and right kidney; this is a relatively easy site to see abnormalities for even the novice sonographer. This view reliably detects volumes of about 600–700 ml of blood; 400–500 ml if the patient is in Trendelenburg. Place the probe longitudinally (with the marker dot directed cephalad) near the mid-axillary line between the 8th and 11th interspaces. This is the *intercostal* approach, which I prefer. The *subcostal* technique may require the patient to be cooperative and take deep breaths, which many cannot. Angle, slide or rock the probe until the right kidney is seen in a longitudinal (coronal) plane, with the hyperechoic, hepatorenal peritoneal reflection in between (*see* Fig. 6.1 *for normal RUQ view*). The normal appearance (negative exam) should look like the kidney capsule is directly abutting the liver edge with nothing in-between. Intraperitoneal blood appears (acutely and classically) as an anechoic (black) stripe between the liver and kidney (Morrison's pouch) and may have varying degrees of echogenicity based on degree of clot and fibrin stranding (*see* Fig. 6.2). To assess for other bleeding sites, direct or slide the US probe cephalad and posterior, through and above the diaphragm, in a coronal plane. This allows you to assess for bleeding within the liver parenchyma, and subdiaphragmatic space, as well as for hemothorax above the diaphragm. Blood or fluid in the thorax will have a V-shaped appearance, while subdiaphragmatic blood will be crescent-shaped (*see* Fig. 6.3). Sensitivity/specificity for detecting 20–50 ml of blood in the hemithorax is >95%, much better than supine CXR at those volumes. Remember on both the RUQ and LUQ views that identifying blood in the chest requires dynamic imaging to identify the location and movement of the diaphragm during normal respirations.

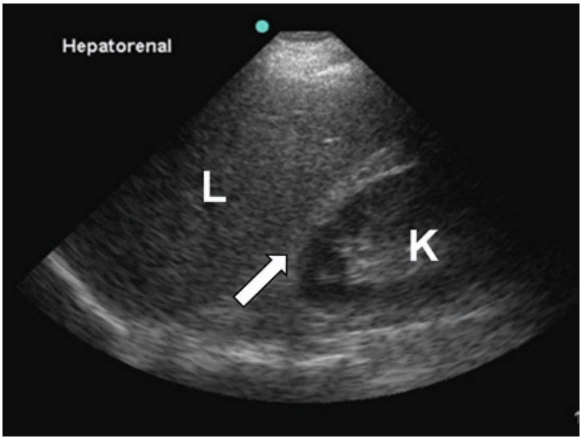

Fig. 6.1 Normal right upper quadrant (hepatorenal) view. Note the normal appearing hyperechoic line (*arrow*) between the liver (L) and right kidney (K)

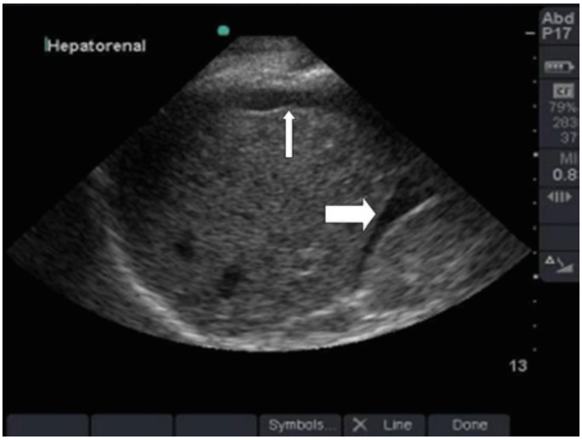

Fig. 6.2 Positive right upper quadrant scan, with *dark stripe* of blood in Morison's pouch (*large arrow*) and above liver in the right subphrenic space (*small arrow*)

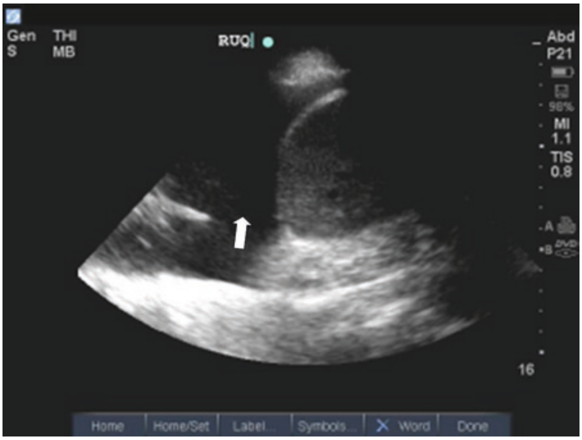

Fig. 6.3 Right sided hemothorax, with hypoechoic collection of blood seen above diaphragm (*arrow*)

LUQ (Perisplenic or Splenorenal) View

This is an intercostal approach and, when placing the probe, think "more posterior and more superior" in comparison to the RUQ view. I reach over the patient and place my right knuckles on the gurney and start near the left posterior axillary line at 9–10th interspace, with the marker dot pointed cephalad, to view the splenorenal junction (*see* Fig. 6.4 *for normal LUQ view*). Sweep the probe anterior and posterior, as well as cephalad and caudal, to look for bleeding from a splenic injury. Similar to the RUQ view, you will look for any blood (black stripe) building up between the kidney and spleen. But you are not done there. Remember that on this side blood most often collects in the subphrenic space, so it is vital to also look above the spleen (*see* Fig. 6.5). In doing so, we can see hypoechoic/anechoic fluid both

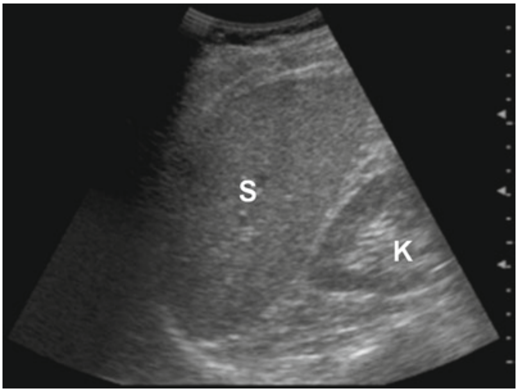

Fig. 6.4 Normal left upper quadrant (splenorenal) view showing the spleen (S) and the left kidney (K). Note the curvilinear, *hyperechoic line* (diaphragm) above the spleen

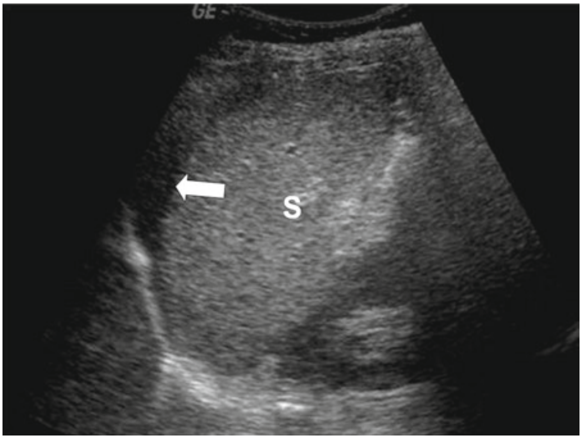

Fig. 6.5 Positive left upper quadrant scan, with *dark stripe* of subdiaphragmatic blood seen above the spleen (*arrow*). Note the crescent shape of blood, as compared to hemothorax, which has sharper or "v" shape

below the diaphragm (hemoperitoneum) and above it (hemothorax) all in one view. While not the primary purpose of EFAST, splenic parenchymal injury can also often been visualized as you perform this view.

Pelvic View

In most patients, this is the most sensitive view in detecting intraabdominal bleeding and only about 100–200 ml is needed for a positive scan. Since a full bladder helps image quality, perform EFAST before Foley catheter placement, or after clamping the catheter and infusing 200 cc of fluid into the bladder. Place the probe just above the symphysis pubis in the midline and angle the probe caudad to look into the pelvis. Obtain both *longitudinal* (probe indicator pointed cephalad) and *transverse* (probe tip to the patient's right) views (*see* Fig. 6.6 *for normal view*) In females, fluid is seen just

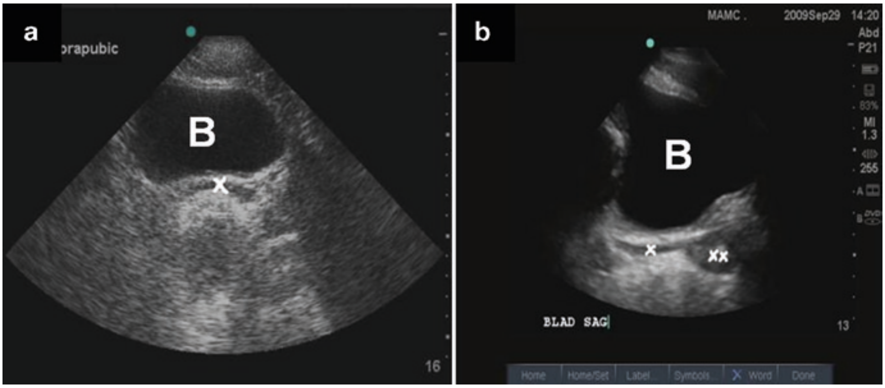

Fig. 6.6 Normal transverse (**a**) and longitudinal (**b**) pelvic views in a male patient (B = bladder, x = seminal vesicles, xx = prostate gland)

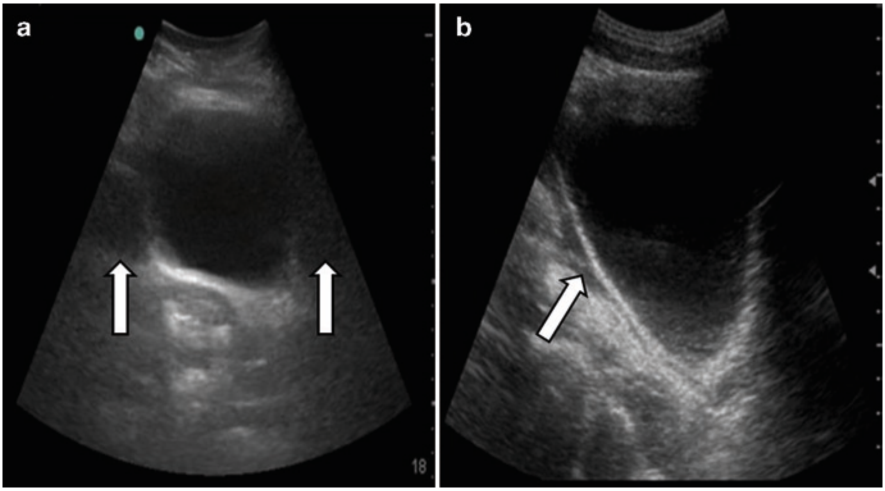

Fig. 6.7 Positive transverse (**a**) and longitudinal (**b**) pelvic views. Hypoechoic blood is seen on either side of the larger, anechoic (*black*) urine-filled bladder in (**a**) (*arrows*). In (**b**), the *dark stripe* of blood outside the bladder (*arrow*) tracks along the intestines and the posterior bladder wall, unlike the rounded edges of urine contained within the hyperechoic bladder walls

posterior to the uterus if a small amount, but may surround the uterus if there are large volumes. In males, fluid is seen behind or above the bladder (*see* Fig. 6.7). A common false positive comes from over-reading the seminal vesicles in males, which lie between the bladder and the prostate; notice their appearance and location as you practice on normals. Free intraperitoneal fluid, unlike fluid within organs, tends to form collections with sharp edges, or triangles, as it settles between structure, rather than rounded edges as seen within a viscus. Free fluid will also change size with patient repositioning and accumulation or drainage of fluid from that space.

Pericardial View

In patients with penetrating trauma who are in extremis, you should do this view first, since hemopericardium would prompt you to perform emergent thoracotomy or sternotomy. The pericardium can be viewed using either the *subcostal* or *transthoracic* views. If the patient can tolerate it, the subcostal view is performed by placing the probe in the subxyphoid space with the beam directed at the left shoulder and the probe indicator towards the patient's right shoulder. For morbidly obese patients or those with significant abdominal pain or upper abdominal injury, try the transthoracic view. The parasternal long axis view of the heart is obtained by placing the probe at the left fourth to fifth intercostals space just left of the sternum(*see* Fig. 6.8). Point the transducer indicator to the patient's right shoulder (10 o'clock) and manipulate it until all four chambers of the heart are seen. Pericardial blood shows up as a black stripe between the myocardium and the hyperechoic pericardium (*see* Fig. 6.9) Pericardial fat can show up as a dark stripe

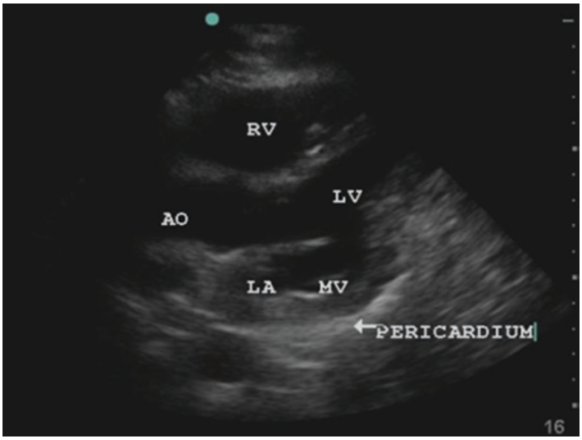

Fig. 6.8 Normal parasternal long axis view of heart. *RV* right ventricle, *AO* aorta, *LV* left ventricle, *LA* left atrium, *MV* mitral valve

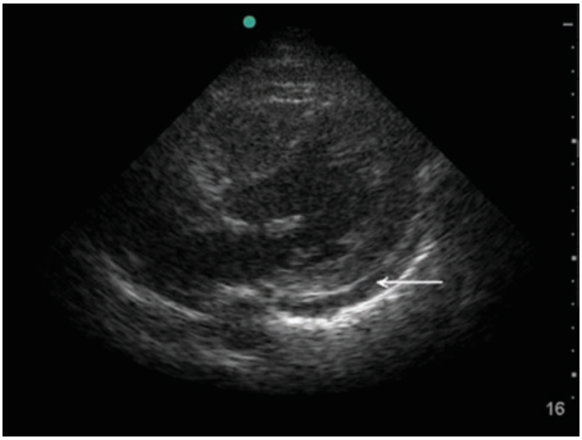

Fig. 6.9 Parasternal long axis view of the heart with *dark stripe* of pericardial effusion (*arrow*)

anterior to the right ventricle, but doesn't surround the entire heart. Slow and fine hand movements can greatly improve your image, or move to a different interspace if you cannot obtain a good ultrasound window at that position.

Pneumothorax Scan

US is about twice as sensitive as supine CXR in evaluating for pneumothorax in the trauma patient, approaching 90–95% sensitivity and 100% NPV. Basically, you are looking for the normal pleural interface (parietal and visceral pleura) sliding across each other. This pleural line is just deep to the rib shadows and is seen as a white, or hyperechoic line (*see* Fig. 6.10). When air is present between this interface, as in a pneumothorax, the normal "*lung sliding*" is absent. This sliding can be evaluated using color power Doppler (CPD) or M-mode; however, neither is necessary if you can see normal sliding. Another normal finding is "*comet tail*" *artifact*, which are white projections that are caused when US waves hit the normal pleural interface. These "rays" project down to the lower edge of the screen and are not seen if air is present. CPD, M-mode and comet tails all require motionless patients and therefore are of marginal utility in the austere environment (e.g. in a Humvee, FLA, Blackhawk or if the patient can't hold still).

The higher frequency (5–10 MHz) transducers show shallow anatomy best and conform nicely to the chest in most patients and should be used to evaluate for pneumothorax. In the supine patient air should collect anteriorly, so place the probe at the mid-clavicular space, identify the ribs first as landmarks for appropriate depth, then identify the pleural line just deep to the ribs and look for normal lung

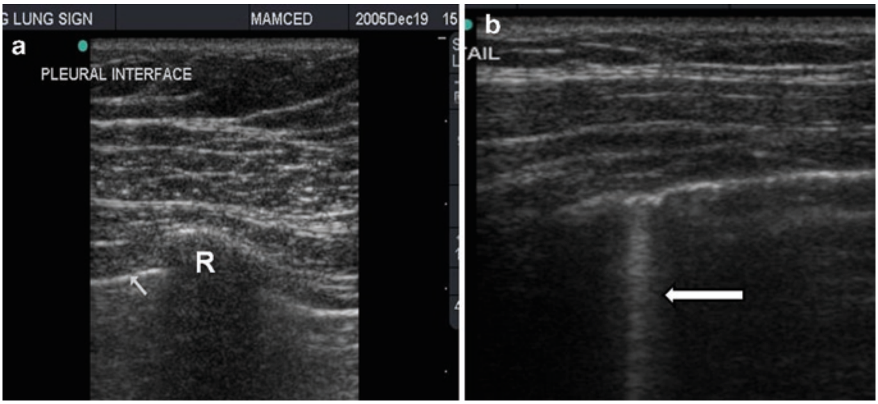

Fig. 6.10 Ultrasound evaluation for pneumothorax performed on anterior chest wall in mid-clavicular line. (**a**) The hyperechoic pleural line (*arrow*) is identified on the deep surface of the rib (R) which demonstrates posterior shadowing. Visible sliding pleural motion on real-time exam of this area rules out a pneumothorax. (**b**) Another finding of a negative examination is a comet tail artifact (*arrow*)

sliding. Repeat this two to three times in different anterior, sagittal planes for each hemithorax, sliding caudal over the anterior chest to the costal margins for each scanning plane. Pause between each interspace to confirm sliding, then as soon as you seen normal sliding, move on. This should only take less than a minute per hemithorax as long as you are sure there is normal sliding. For patients with hemodynamic instability or high suspicion (penetrating shrapnel wounds, crepitus, etc…), place a tube thoracostomy if no sliding is seen. Occasionally, patients arriving to our CSH had needle thoracostomies placed in the field but had normal underlying lung sliding on US, indicating no pneumothorax (later confirmed with CT) and thus obviating the need for immediate (or any) chest tubes. False positive findings may be seen with: (1) mainstem bronchus intubations (no sliding on opposite, normal lung) (2) Patients with previous underlying lung disease with adhered pleura/scarring (usually older, civilian casualties) and (3) normal lack of sliding near the pericardial-pleural interface on the left.

Making Clinical Decisions with EFAST Findings

In combat, US findings are acted upon primarily based on the type of injury, clinical stability and the operating environment available. Patients with hemodynamic instability and clear indications for surgery should be taken emergently to the OR without significant delay for imaging. In penetrating injury, perform EFAST when immediate surgery isn't clearly indicated, especially if multiple penetrating wounds are present, or high velocity GSW may have traversed multiple body cavities. US may help to prioritize surgical interventions such as pericardiotomy, thoracotomy, laparotomy or sternotomy. In patients going for emergent/urgent laparotomy, US can quickly rule out pericardial blood or pneumo/hemothorax enroute to or in the OR. EFAST findings can prioritize patients for evacuation and in mass casualty settings as well. In stable patients with blunt trauma, CT (if available) is a reasonable choice for an EFAST that shows intraperitoneal blood if nonoperative management is being considered. CT should always be performed for an equivocal/indeterminate FAST exam if available. If not, then close observation with serial exams or a diagnostic peritoneal lavage (DPL) can be performed. In the unstable patient with an equivocal or indeterminate FAST exam, you can quickly rule out abdominal hemorrhage as the source by performing a diagnostic peritoneal aspirate (DPA). Using either a standard DPL catheter or simply a syringe with an 18 gauge needle, aspirate as you penetrate the peritoneum (pelvis and/or paracolic gutters) with the needle. Any return of gross blood is positive and should prompt a laparotomy. See Chap. 5 for more on operative decision making, but try to do a quick EFAST if time allows in even the most critical patients, since you can quickly get a lot of useful information that may guide the sequencing of initial surgical resuscitation.

Other Useful Applications

Evaluation of Hemodynamic Status/CVP Measurement

US has additional utility in evaluating the patient in undifferentiated shock, looking for causes such as cardiac contusion/infarction, hemorrhagic shock, sepsis, pulmonary embolus and cardiac tamponade. While specific echo findings are outside the scope of this chapter, these are skills that can easily be picked up with some "off the cuff" training by the intensivists, emergency physicians and trauma trained surgeons with whom you deploy. To estimate the CVP in any of these scenarios utilizing US, place the low frequency probe in the sagittal plane (probe held longitudinally, marker cephalad) in the subxiphoid region to see the right atrial-vena caval junction (*see* Fig. 6.11). The IVC immediately adjacent to the right atrium (RA) responds directly to the pressure of the right atrium and is a rough estimate of RA pressure. CVP *estimate* may be made based on the IVC size (normally 1.5–2.5 cm diameter) and response to inspiration in the following manner:

(a) Total or significant IVC collapse at inspiration → Low RA pressure patient needs volume resuscitation and/or hemorrhage control
(b) Normal sized IVC and moderate collapse (less than 50%) → Normal RA pressure
(c) Large sized IVC and little or no IVC collapse → High RA pressure volume overload, cardiac tamponade, heart failure

IVC estimation can be a helpful adjunct, but it should not be used as a sole deciding factor early in the resuscitation. Make initial management decisions based on the

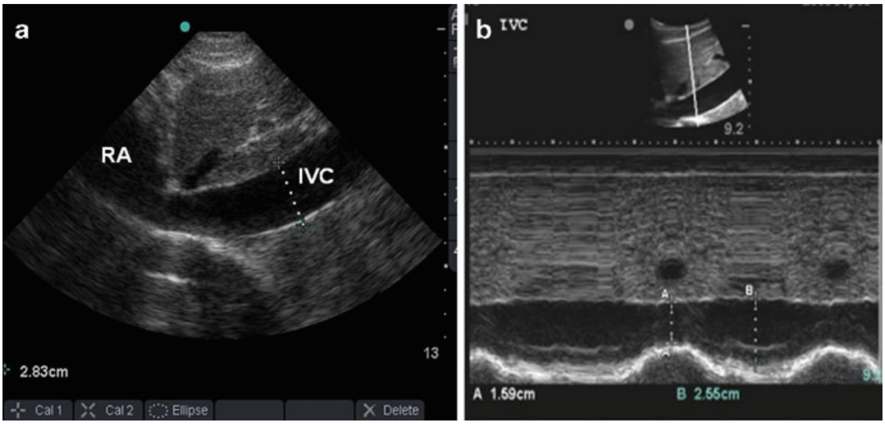

Fig. 6.11 Ultrasound evaluation of the inferior vena cava for volume assessment. (**a**) The vena cava (IVC) is demonstrated as it enters the right atrium (RA) in longitudinal section and the measurement of 2.8 cm suggests adequate intravascular volume. (**b**) M-mode evaluation of the vena cava is used to compare the diameter at inspiration (**a**) to that at expiration (**b**). Note that this vessel shows less than 50% collapse, again indicating adequate intravascular volume status

patient's hemodynamic stability, history and clinical evaluation of injuries. IVC estimation may certainly be useful later in the postoperative phase, as when receiving patients from a FST after damage controlled resuscitation or other "used" civilian and military trauma victims. This is very subjective measurement that also requires you to see many normal studies to recognize when abnormal.

Triage

Mass casualty scenarios are always a possibility on today's battlefield. Most commonly, "Mini-Mass-Casualty" scenarios are encountered when explosive devices injure several or more patients that you are called to assess. US can be an invaluable tool in gaining a lot of useful information in a short amount of time. If the surgeons and emergency physicians are busy leading the resuscitations, other trained team members can serve in this role. Radiologists, OBGYN doctors, nurses and even combat medics can be trained to perform EFAST when your trauma team and usual sonographers are tied up.

Procedural

Central line placement under US guidance is becoming the standard because data suggest there are fewer complications than when doing them blind. If time allows in the stable patient, this is a great time to refine this skill as well. Other common procedures such as thoracentesis, paracentesis, percutaneous abscess drainage, and pericardiocentesis are greatly enhanced by the addition of ultrasound guidance.

Foreign Body/Soft Tissue/Musculoskeletal Application

You may be assigned to a FST working outside of a CSH, or in some other scenario where you do not have radiographic or CT support. US can be very useful in identifying soft tissue foreign bodies, differentiating cellulitis from abscess, and evaluating other soft tissue injuries and infections. With practice, you can assess for long bone fractures and dislocations without plain x-rays in even the most austere settings.

Other

While outside the scope of this chapter, other relatively easy scans that may be performed in the austere setting include: gallbladder (stone/infection), hydronephrosis from kidney stone, AAA and pregnancy scanning for IUP vs. ectopic. Many other applications, such as retinal detachment or ocular foreign bodies, compression studies of the lower extremity venous system for DVT and testicular ultrasound are easily performed with the basic US system that most units deploy with to OIF/OEF.

In conclusion, the utility and applications of ultrasound technology in combat trauma have been solidly established and continue to rapidly expand. The flexibility, portability, and ease of use of modern ultrasound platforms make this an ideal imaging modality which is becoming a standard adjunct to the physical examination. Your investment of time in developing a solid foundation of ultrasound skills will pay great dividends in any forward deployed or disaster scenario you may be faced with.